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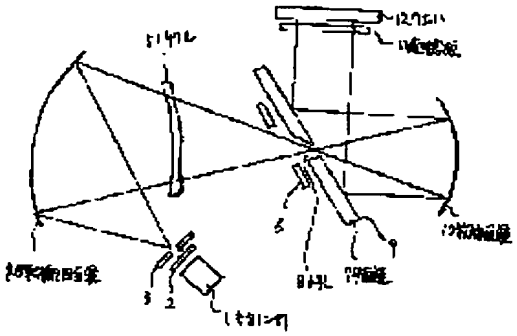
(54) OPTICAL SYSTEM FOR LSI MANUFACTURING CONTRACTION PROJECTION ALIGNER BY LIGHT

(57)Abstract:

PURPOSE: To obtain a mirror type stepper in which a short wavelength ultraviolet ray is used as a light source and which has a deep focal depth, a wide exposure area and a large numerical aperture.

CONSTITUTION: A light source is mounted at one focal point of a rotational elliptical concave mirror, the small hole 8 of the mirror 7 is mounted at the other focal point, and the hole 8 also becomes a focal point of a parabolic mirror 10. A high coherent light is used as a light source thereby to deepen a focal depth, to remove various aberrations and to improve an effective numerical aperture. Further, a reticle image is increased larger than an image on a wafer and the width of the wavelength of an illumination light is increased thereby to prevent deterioration of the image due to the use of the coherent light. In this case, its resolution is improved when transparent liquid is filled between optical systems.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] Optical system of the LSI manufacture contraction projection aligner characterized by having been in agreement in the stoma which has the exposure device concentrated on one point ahead of a reticle, and a plane mirror has in one point which the light concentrates, having installed the plane mirror, and installing a concave mirror in the confrontation of the mirror plane of the plane mirror.
[Claim 2] LSI manufacture contraction projection aligner of the structure which fills the space between optical system with a transparent liquid, and is carrying out circulation ** of the transparent liquid according to claim 1.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001] [Field of the Invention] this invention relates to the optical system of the LSI manufacture contraction projection aligner (stepper) by mirror type light.
[0002] There is a stepper a mirror type actual size package projection aligner and lens type conventionally [[conventional technical]].
[0003] -- since only the linear image of the rate of actual size is obtained in the optical system of the mirror type actual size package projection aligner of the [Problem(s) to be Solved by the Invention] former, the precision alignment of a mask image is difficult, the effect by dust is large, and it is difficult to correct all defects -- etc. -- there was a problem.
[0004] At the stepper conventional lens type, the problem of the little of the usable transparence matter, the lowness of transparency, and the endurance of a lens was in the lens by ultraviolet C.
[0005] This invention has the optical system of the mirror type which can use ultraviolet C, and aims at offering the stepper which has the deep depth of focus in high resolution and a large exposure area.
[0006] In order to attain the [The means for solving a technical problem] above-mentioned purpose, it sets to the optical system of this invention stepper. It is in agreement with one ****** of the light in the stoma which a plane mirror has, and a plane mirror is installed. the high coherent light of a comparatively large wavelength region -- the light source -- carrying out -- a condensing concave mirror -- one ahead of a reticle -- the inside of ** -- putting -- [0007] -- [0008] A concave mirror is installed in the confrontation of the mirror plane of the plane mirror, and it is made in agreement [the focus of the concave mirror and the stoma of a plane mirror].
[0009] a very thin transparence aperture plate perpendicular to the parallel ray to which a reticle is irradiated, and the light from the light source passes the stoma of a plane mirror, serves as a parallel ray mostly with a concave mirror, and reflects and advances with the same plane mirror -- installing -- [0010] -- approach the transparence aperture plate extremely, install a wafer, and carry out contraction image formation of the reticle image on the wafer.
[0011] And the reticle is produced on the curved surface which amends image surface curvature.
[0012] the space between optical system -- a transparent liquid -- filling -- the transparent liquid -- circulation **** -- it is effective by the reason things carry out a postscript.
[0013] -- the light which penetrated the [operation] reticle -- high -- if it is coherent and the aperture D and the focal distance of wavelength lambda and a condensing concave mirror are set to f, it will concentrate on the stoma of the plane mirror which has 84.6% of the total quantity of light ahead of a reticle in the radius of gamma=1.22lambdaf/D. The perimeter presents the diffraction figure of a reticle.
[0014] Since the reticle and the transparence aperture plate are made of synthetic quartz in this invention, a front face can be ground smoothly and the effect of the front face by high coherent light use is small.
[0015] In this invention, since it is isolated with the external world that it is also at a transparence aperture, the convection current of air has prevented invasion of dust few again. If whole this invention is brought close to a vacuum, the convection current of air and the effect of dust will become small.
[0016] opposite -- the space between mirror optics systems -- a transparent liquid -- filling -- the transparent liquid -- circulation **** -- by things, the effect of the front face of a reticle and a transparence aperture plate becomes small, and the effect of dust becomes small. And change is prevented for the rate of optical refraction by the temperature rise for light to be absorbed by the transparent liquid.
[0017] A transparence aperture is very thin, and since it is installed in the light and the perpendicular which were reflected with the concave mirror and the plane mirror, don't produce chromatic aberration.
[0018] In this invention, since the electrostatic precipitator is installed in the perimeter of the stoma of a

monotonous mirror between a monotonous mirror and a reticle, the dust in a stepper was removed and invasion of the dust to the mirror optics system which leads the stoma of a monotonous mirror has been prevented.

[0019] In this invention, since it is so good that the image pattern on a reticle has many transparent parts, it is necessary to take into consideration in image formation. It may be better to enforce reversal of the image of a photoresist depending on an image pattern.

[0020] Although the deficit section corresponding to [in LSI manufactured by this invention stepper] the stoma of a monotonous mirror to a core exists, since a stoma is the diameter of about 1mm, there is no effect to an LSI degree of integration. If the quantity of light of the light source can be enlarged, of course, the diameter of a stoma can be set up smaller.

[0021] If a [example] example is explained with reference to a drawing In drawing 1 , it installs in the optical path of the light from xenon LGT 1 in xenon LGT 1, a filter 2, a slit 3, the rotation ellipse concave mirror 4, a reticle 5, the stoma 8 of a plane mirror 7, a parabolic mirror 10, a plane mirror 7, the transparence aperture plate 11, a wafer 12, and this sequence. The stoma 8 of a plane mirror 7 is installed in one focus of a rotation ellipse concave mirror at a slit 3 and another focus. Moreover, the stoma 8 also serves as a focus of a parabolic mirror 10 at coincidence. At this time, the mirror plane 9 of a plane mirror 7 faces a parabolic mirror 10, and is installed, and the electrostatic precipitator 6 is attached in the perimeter of a stoma 8.

[0022] Some kinds of gas, such as AgammaF and KgammaF, is mixed instead of xenon LGT 1, and there is an example which made the agitation **** excimer laser the light source for oscillation wavelength.

[0023] There is an example which used the lens for aberration amendment instead of the transparence aperture plate 11.

[0024] There is an example which used other concave mirrors, such as a spherical mirror and a hyperboloid mirror, instead of the parabolic mirror 10.

[0025] In the example shown in drawing 2 , the space between optical system is filled with a transparent liquid, and circulation ** of the transparent liquid is carried out. The reticle 5 is dipped in the tub 13 which fills a transparent liquid.

[0026] Since [effectiveness of design] this invention is constituted as explained above, it does so effectiveness which is indicated below.

[0027] Since high coherent light is used for the reticle exposure light source and it is very among ** in one ahead of a reticle with a rotation ellipse concave mirror, if the aperture D and the focal distance of wavelength lambda and a rotation ellipse concave mirror are set to f, it will be concentrated on the stoma of the plane mirror which has 84.6% of the total quantity of light ahead of a reticle in the radius of gamma=1.22 f/D. Although the perimeter of a stoma serves as a diffraction figure of a reticle, since the core of a stoma serves as the very high quantity of light as compared with the FUCHI section of the shape of a circumference ring of the width of face of the wavelength of the light of a stoma, the rate which light passes the FUCHI section of a stoma and diffraction produces is very small. Therefore, the fall of the resolution by light passing a stoma is very small. This effectiveness becomes large as a stoma approaches the radius of gamma=1.22lambdaf/D.

[0028] As for the great portion of light which reaches each point of the image on the front face of a wafer, since it is reflected in the very small range in which a parabolic mirror corresponds, the depth of focus has also become and aberration other than image surface curvature or image surface distortion has become very small.

[0029] moreover -- since the great portion of light which reaches each point of the image on the front face of a wafer is reflected in the very small range in which a parabolic mirror corresponds -- count of a parabolic mirror -- effective numerical aperture becomes large from top numerical aperture.

[0030] Since it is the type reduced to about [of a reticle image] 1/10 although speckle noise etc. appears in the diffraction development of a reticle image when high coherent light is used for the exposure light source, even if it uses high coherent light for the light source that a large reticle image pattern can be taken and by taking large wavelength **** since there is no chromatic aberration, there is no degradation of an image.

[0031] By this invention stepper, as for about 0.35 numerical aperture about exposure area phi30mm and on count, and (effective numerical aperture, size) is obtained more.

[0032] Since mirror type optical system is being used for this invention, ultraviolet C can be used for it from a lens type optical-system use stepper.

[0033] When the refractive index of lambda and a transparent liquid is set to eta for the wavelength of light by filling the space between optical system with a transparent liquid, there is the same effectiveness using the light of lambda/eta.

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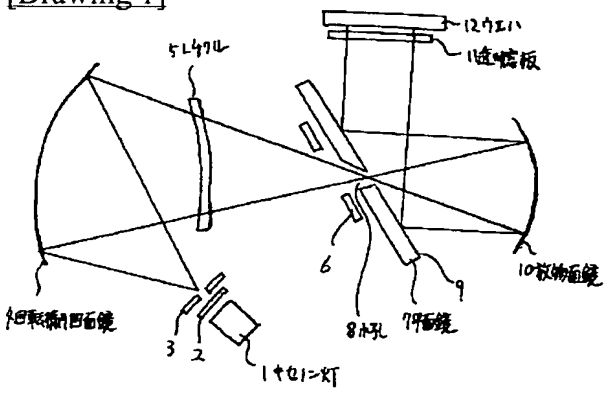
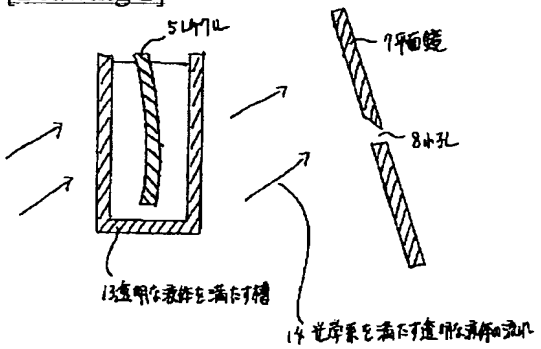
DRAWINGS

[Drawing 1]



[Drawing 2]



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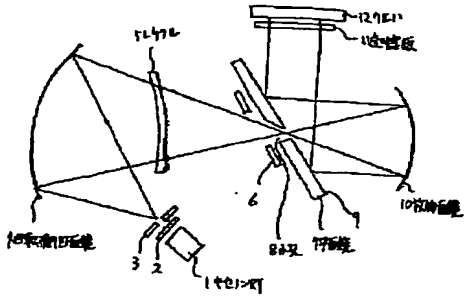

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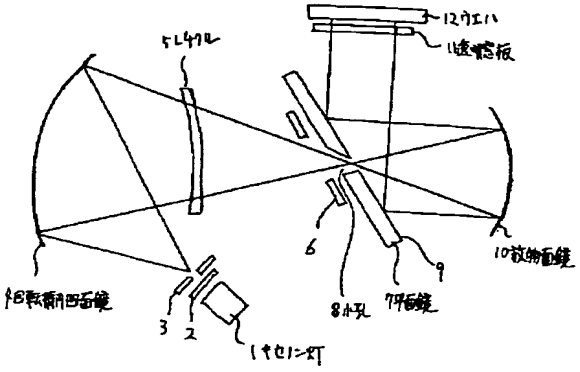
(54)【発明の名称】　光によるＬＳＩ製造縮小投影露光装置の光学系

(57)【要約】

〔目的〕　短波長紫外線を光源とした、焦点深度が深く露光面積が広くかつ開口数の大きい、ミラータイプのステツパを得る。

〔構成〕　回転楕円凹面鏡の一方と焦点に光源を，もう一方の焦点に平面鏡７の小孔８を設置し、かつその小孔８は放物面鏡１０の焦点にもなっている。

〔効果〕　高コヒーレント光を光源とすることにより，焦点深度を深くし種々の収差を除き実効開口数を向上した。又レチクル像をウエハ上の像より大きくとることと、照射光の波長域幅を広くとることにより高コヒーレント光使用による像の劣化を防いでいる。この時光学系間を透明な液体で満たすと解像力が向上する。



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【特許請求の範囲】

〔請求項１〕　レチクルの前方の一点に集中する照射機構を有し、その光の集中する一点に平面鏡の有する小孔を一致して平面鏡を設置し、その平面鏡の鏡面の対面に凹面鏡を設置したことを特徴とするＬＳＩ製造縮小投影露光装置の光学系。

〔請求項２〕　光学系の間の空間を透明な液体で満たし、その透明な液体を循環さしている構造の請求項１記載のＬＳＩ製造縮小投影露光装置。

【発明の詳細な説明】

〔０００１〕〔産業上の利用分野〕本発明は、ミラータイプの光によるＬＳＩ製造縮小投影露光装置（ステツパ）の光学系に関する。

〔０００２〕〔従来の技術〕従来ミラータイプの等倍一括投影露光装置、レンズタイプのステツパがある。

〔０００３〕〔発明が解決しようとする課題〕従来のミラータイプの等倍一括投影露光装置の光学系では、等倍率の線状の像しか得られていないので、マスク像の精密位置合わせが難しく、塵埃による影響が大きく、全欠陥を修正することが困難である等の問題があった。

〔０００４〕従来のレンズタイプのステツパでは、短波長紫外線でレンズに使用可能な透明物質の少なさ、透明度の低さ、又レンズの耐久性の問題があった。

〔０００５〕本発明は、短波長紫外線を使用することのできるミラータイプの光学系を有し高解像度、広い露光面積で深い焦点深度を有するステツパを提供することを目的としている。

〔０００６〕〔課題を解決するための手段〕上記目的を達成するために、本発明ステツパの光学系においては、比較的広い波長域の高コヒーレント光を光源とし、集光凹面鏡にてレチクルの前方の一点に集中さし

〔０００７〕その光の集中す一点に平面鏡の有する小孔を一致して平面鏡を設置し、

〔０００８〕その平面鏡の鏡面の対面に凹面鏡を設置し、その凹面鏡の焦点と平面鏡の小孔とが一致する様にする。

〔０００９〕光源からの光がレチクルを照射し、平面鏡の小孔を通過し凹面鏡でほぼ平行光線となり、同じ平面鏡で反射して進行する平行光線に垂直な極めて薄い透明窓板を設置し、

〔００１０〕その透明窓板に極めて近接して、ウエハを設置しそのウエハ上にレチクル像を縮小結像する。

〔００１１〕そしてレチクルは、像面彎曲を補正する曲面に作製している。

〔００１２〕光学系の間の空間を透明な液体で満たし、その透明な液体を循環さすことが後記する理由により効果的である。

〔００１３〕〔作用〕レチクルを透過した光も高コヒーレントであり、波長λ，集光凹面鏡の口径Ｄ，焦点距離をｆとすると、γ＝１．２２λｆ／Ｄの半径内に全光量

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の８４．６％がレチクルの前方にある平面鏡の小孔に集中する。その周囲はレチクルの回折像を呈する。

〔００１４〕本発明ではレチクル、透明窓板は合成石英で出来ているので、表面を滑らかに研磨でき、高コヒーレント光使用による表面の影響が小さい。

〔００１５〕本発明では、透明窓でもって外界と隔絶されているので、空気の対流が少なく又塵埃の侵入を防いでいる。本発明全体を真空に近づけると、空気の対流や塵埃の影響が小さくなる。

〔００１６〕反対にミラー光学系の間の空間を透明な液体で満たし、その透明な液体を循環さすことにより、レチクル，透明窓板の表面の影響は小さくなり、又塵埃の影響が小さくなる。そして透明な液体に光が吸収されるための温度上昇による光の屈折率を変化を防いでいる。

〔００１７〕透明窓は極めて薄く、凹面鏡と平面鏡とで反射された光と垂直に設置されているので、色収差は生じない。

〔００１８〕本発明では、平板鏡とレチクルとの間に平板鏡の小孔の周囲に電気集塵装置を設置しているので、ステツパ内の塵埃を取り除き、平板鏡の小孔を通じてのミラー光学系への塵埃の侵入を防いでいる。

〔００１９〕本発明では、レチクル上の像パターンは透明な部分が多い程良いので、像形成にあたって考慮する必要がある。像パターンによっては、ホトレジストの像の反転を施行した方が良い場合もありうる。

〔００２０〕本発明ステツパで製造したＬＳＩは、中心部に平板鏡の小孔に対応する欠損部が存在するが、小孔は直径１ｍｍ程度であるので、ＬＳＩ集積度に対する影響はない。もちろん光源の光量を大きく出来れば、小孔の直径はもっと小さく設定できうる。

〔００２１〕〔実施例〕実施例について図面を参照して説明すると、図１においてキセノン灯１，フイルタ２，スリット３，回転楕円凹面鏡４，レチクル５，平面鏡７の小孔８，放物面鏡１０，平面鏡７，透明窓板１１，ウエハ１２，とこの順序でキセノン灯１からの光の光学的通路に設置し、回転楕円凹面鏡の一方の焦点にスリット３，もう一方の焦点に平面鏡７の小孔８を設置する。又小孔８は同時に放物面鏡１０の焦点ともなっている。この時平面鏡７の鏡面９は放物面鏡１０と向かいあって設置され、小孔８の周囲には電気集塵装置６が取り付けられている。

〔００２２〕キセノン灯１の代りにＡｒＦ，ＫｒＦ等の数種類のガスを混合し、発振波長を動揺さすエキシマレーザーを光源とした実施例がある。

〔００２３〕透明窓板１１の代りに収差補正用レンズを使用した実施例がある。

〔００２４〕放物面鏡１０の代りに球面鏡，双曲面鏡等他の凹面鏡を使用した実施例がある。

〔００２５〕図２に示される実施例では、光学系の間の空間を透明な液体で満たし、その透明な液体を循環さし

ている。レチクル５は透明な液体を満たす槽１３に浸されている。

〔００２６〕〔考案の効果〕本発明は、以上説明したように構成されているので、以下に記載されるような効果を奏する。

〔００２７〕レチクル照射光源は、高コヒーレント光を使用し、回転楕円凹面鏡にてレチクルの前方の一点に集中さしているので、波長λ，回転楕円凹面鏡の口径Ｄ，焦点距離をｆとすると，γ＝１．２２ｆ／Ｄの半径内に全光量の８４．６％がレチクルの前方にある平面鏡の小孔に集中する。小孔の周囲はレチクルの回折像となるが、小孔の中心部は小孔の光の波長の幅の周辺リング状のフチ部と比較して極めて高い光量となるので、小孔のフチ部を光が通過して回折が生じるその割合は極めて小さくなっている。従って光が小孔を通過することによる解像力の低下は極めて小さい。この効果は小孔がγ＝１．２２λｆ／Ｄの半径に近づくにつれて大きくなる。

〔００２８〕ウエハの表面上の像の各点に到達する光の大部分は、放物面鏡の対応する極めて小さい範囲で反射されたものであるので、焦点深度も深く像面彎曲や像面歪曲以外の収差は極めて小さくなっている。

〔００２９〕又ウエハの表面上の像の各点に到達する光の大部分は、放物面鏡の対応する極めて小さい範囲で反射されたものであるので、放物面鏡の計算上な開口数より実効開口数は大きくなる。

〔００３０〕照射光源に高コヒーレント光を使用すると、レチクル像の回折現像でスペツクル雑音等が出現するが、レチクル像の１０分の１程度に縮小するタイプであるため、レチクル像パターンを大きくとる事ができることと、色収差がないので波長域幅を広くとることにより、高コヒーレント光を光源に使用しても像の劣化はな＊い。

〔００３１〕本発明ステツパで、露光面積φ３０ｍｍ程度、計算上の開口数０．３５程度、（実効開口数はもっと大）が得られる。

〔００３２〕本発明は、ミラータイプの光学系を使用しているので、レンズタイプの光学系使用ステツパより短波長紫外線を使用できる。

〔００３３〕光学系の間の空間を透明な液体で満たすことにより、光の波長をλ，透明な液体の屈折率をηとすると，λ／ηの光を使用したと同じ効果がある。

【図面の簡単な説明】

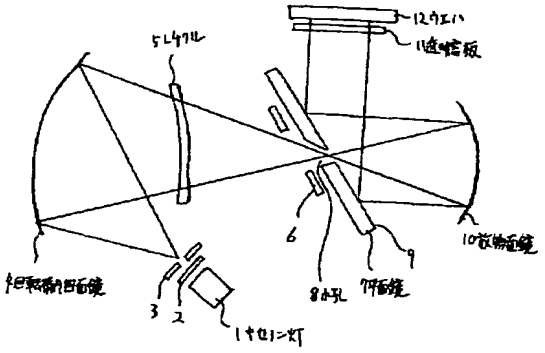
〔図１〕本発明ステツパの１実施例の構成ブロツク図である。

〔図２〕本発明ステツパの光学系間を透明な液体で満たした実施例のレチクル周辺部の構成図である。

〔符号の説明〕

１	キセノン灯
２	フイルタ
３	スリツト
４	回転楕円凹面鏡
５	レチクル
６	電気集塵装置
７	平面鏡
８	小孔
９	平面鏡の鏡面
１０	放物面鏡
１１	透明窓板
１２	ウエハ
１３	透明な液体を満たす槽
１４	光学系を満たす透明な液体の流れ

【図１】



【図２】